NANOFAB TOOL RATES
Effective 6/30/14

Category	Tool	Description	Location	Tool Usage Full Rate $/Hour	Tool Usage Reduced Rate $/Hour
Chemical Vapor Deposition	Oxford FlexALRPT Atomic Layer Deposition	Thermal and plasma ALD Processes for platinum, silicon oxide, aluminum oxide, titanium oxide, and halfnium oxide, up to 200 mm substrates.	C	116	58
	Plasma-Therm Versaline High Density PECVD	Low temperature deposition of oxide, nitride and amorphous silicon thin films, up to 200 mm substrates.	C	145	72
CMOS	Unaxis Shuttleline ICP Etcher	Clorine etching of silicon for ultra-clean applications.	C	178	89
	Tystar Wet Oxidation Furnace	Pyrogenic oxidation of silicon up to 1150 °C.	C	152	76
	Tystar Dry Oxidation Furnace	Dry oxidation of silicon up to 1150 °C.	C	152	76
	Tystar Sinter Furnace	10% forming gas and nitrogen anneal.	C	85	43
	Tystar Doping Furnace	Phosphorus and boron doping of silicon.	C	85	43
	Tystar Polysilicon Low Pressure CVD	CMOS doped and undoped polysilicon deposition.	C	138	69
	Tystar Silicon Nitride Low Pressure CVD	Low stress and stoichometric silicon nitride deposition.	C	135	68
	Tystar Low Temperature Oxide CVD	Low temperature oxide deposition.	C	142	71
Dry Etching	Unaxis Shuttleline Deep Si Etcher	Bosch process capability 1 um per minute to 15 um per minute with high selectivity (> 100:1 silicon oxide, > 40:1 photoresist).	C	132	66
	SPTS Omega c2L Deep Silicon Etcher	High aspect ratio deep silicon etching on wafers up to 200 mm. "Bosch" process capability with higher etch rates and smoother feature sidewalls.	C	150	75
	Oxford PlasmaLab 100	Chlorine or fluorine etching especially suited to III-V, metals, and anisotropic silicon etching, cryogenic and high temperature etch capability - 150 °C to 400 °C, up to 200 mm wafer capable.	C	137	68
	Oxford PlasmaLab 100	Chlorine or fluorine Etching especially suited to III-V, metals, and anisotropic silicon etching, cryogenic and high temperature etch capability - 150 °C to 400 °C, up to 200 mm wafer capable.	C	137	68
	Unaxis 790 RIE	General fluorine etching of dielectrics and metals.	C	113	57
	Unaxis 790 RIE	General fluorine etching of dielectrics and metals.	C	113	57
	XeF2 Silicon Etcher	High rate silicon removal for mems release etch.	C	130	65
	SPTS µEtch HF Vapor Etcher	A combination of liquid hydrofluoric acid and alcohol isotropically etches silicon dioxide while not etching silicon. Substrates up to 200 mm.	C	100	50
	Microwave Asher	Polymer removal and surface clean.	C	80	40
	4Wave Ion Mill	Argon ion milling of metals and dielectrics (150 mm wafer maximum), large 22 cm ion source provides < 1% non-uniformity, low base pressure, fast cycle, SIMS endpoint detection, reactive ion beam etch capable with oxygen and fluorocarbons.	C	133	67
Gen Furnaces	Tystar Dry Ox Furnace	Dry oxidation of silicon up to 1200 °C.	C	79	39
	Tystar Wet Ox Furnace	Pyrogenic oxidation of silicon up to 1150 °C.	C	82	41
	Tystar Sinter Furnace	10 % forming gas and nitrogen anneal.	C	84	42
	Tystar Anneal Furnace	Nitrogen and oxygen anneal up to 1100 °C.	C	79	39
	Modular Process Rapid Thermal Annealer	Rapid thermal processing up to 1200 °C in nitrogoen, oxygen, argon, 10% forming gas, up to 150 mm wafers.	C	161	80
Imaging and Analysis	FEI Titan Analytical TEM	Information Limit 0.10 nm, STEM resolution 0.14 nm, 80 kV to 300 kV, Gatan Orius 2k x 2k digital camera, Fischione HAADF STEM detector, Gatan GIF for EELS and EFTEM, EDAX EDS for elemental detection and mapping. Tomography acquisition, reconstruction, and analysis software.	E	170	85
	Zeiss Ultra 60 Field Emission SEM	1.5 nm resolution, 1 keV to 30 keV, Oxford EDS for detection and mapping of elements beryllium and heavier, in lens and Everhart Thornley secondary detectors, and in lens energy selective and four quad backscatter detectors, up to 150 mm wafers.	C	131	66
	Fischione 1040 NanoMill Low Energy Ion Mill	Low energy ion mill for final thinning of TEM specimens.	E	155	77
	Wyatt Dawn Heleos II DLS	Nanoparticle characterization system integrates several methods of field flow fractionation and light scattering to separate and measure nanoparticles in solution.	E	50	25
	Rigaku SmartLab 9kW X-Ray Diffraction	High resolution multipurpose x-ray diffractometer, 9 kW rotating anode x-ray generator, high temperature measurements up to 1100 °C in air, vacuum, and inert gas; measurements including film thickness, roughness, density, crystallographic texture, and film and crystal quality measurements.	C	150	75
	Bruker Fast Scan AFM	Wafer scale AFM capability on wafers up to 200 mm for fast scanning of multiple sites on a wafer. Contact, tapping, and phase imaging modes, up to 200 mm substrates, electrostatic force microscopy, magnetic force microscopy.	C	137	68
	Asylum Cypher High Resolution AFM	High resolution AFM capability on wafers up to 20 mm for multipurpose research applications. Contact, tapping, and phase imaging modes, electrostatic force microscopy, magnetic force microscopy.	E	130	65
	Veeco Dimension 3100 Atomic Force Microscope	Contact, tapping, and phase imaging modes, up to 200 mm substrates, electrostatic force microscopy, magnetic force microscopy.	C	130	65

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NANOFAB TOOL RATES
Effective 6/30/14

Category	Tool	Description	Location	Tool Usage Full Rate $/Hour	Tool Usage Reduced Rate $/Hour
Focused Ion Beams	FEI Helios 650 Dual Beam FIB/SEM	SEM Imaging resolution < 1 nm from 1 kV to 30 kV, FIB resolution 2.5 nm at 30 kV, STEM detector, integrated Oxford EDS for detection and mapping of elements beryllium and heavier, beam deceleration for 50 V effective landing voltage, Kleindiek in-situ probe system for nanopositioning and electrical measurement, gas injection system supports platinum, gold, carbon, insulator deposition and selective carbon and insulator enhanced etch, slice and view 3D reconstruction, TEM lamella prep, circuit editing, wafers up to 150 mm.	E	309	154
	Zeiss NVision40 Dual Beam FIB/SEM	SEM imaging resolution 1.1 nm at 20 kV, FIB resolution 4 nm at 30 kV, gas injection system supports platinum, tungsten, carbon, and insulator deposition, slice and view 3D reconstruction, TEM lamella prep, circuit editing, load lock for fast sample change, wafers up to 100 mm.	E	267	133
Lithography	JEOL E-beam JBX 6300-FS	2 nm spot size, 12 MHZ write speed, 200 mm loadable.	E	575	287
	Raith Elphy E-beam	Ion beam 4 nm spot size at 30 kV, electron beam 1 nm spot size at 20 kV, 100 mm loadable, integrated with Zeiss N-Vision 40 FIB/SEM.	C	131	66
	ASML Stepper PAS 5500/275	High throughput 5x projection I-Line lithography; < 300 nm resolution; 3D backside alignment, 200 mm loadable, 22 mm x 27 mm field size.	C	215	107
	Suss MA6 Contact Lithography	I or G line contact exposure with front and back side alignment, 1 um resolution, up to 150 mm substrate.	C	63	31
	Suss MA8 Contact Lithography	I or G line contact exposure, 1 um resolution, up to 200 mm substrate.	C	63	31
	Heidelberg DWL-66FS Laser Writer	Less than 1 um resolution, greyscale writing modes,backside alignment capable, direct substrate write or mask exposure.	C	133	67
	Nanonex NX-2000 Nano-imprinter	UV and thermal large area imprint, features down to 10 nm.	C	153	76
	Nanonex Ultra-100 Molecular vapor coater	UV-Ozone clean and molecular vapor coating capabilities to support nano-imprint processes on substrates up to 150 mm diameter.	C	139	70
Packaging	Disco 341 Dicing Saw	Wafer dicing (200 mm wafer maximum).	E	100	50
	K&S 4526 Wire Bonder	Manual wire bonder for electrical interconnect. Dedicated gold and aluminum bonders.	E	128	64
	Tresky T-3000-FC3-HF Flip Chip Bonder	Eutectic, ultrasonic, thermal, and epoxy bonding, 1 um positioning accuracy, substrates up to 40 mm thick and 150 mm diameter.	E	147	74
Physical Vapor Deposition	Denton Infinity 22	Thermal and E-beam evaporation of over 30 metal and dielectric sources provided, co-evaporation available, ion assist, ion wafer clean, fast cycle under 30 minute pumpdown.	C	128	64
	Denton Discovery 550	RF and DC sputtering of over 30 metal and dielectric targets provided, magnetically enhanced gun, up to 600 W, heated stage to 350 °C, co-sputtering available, wafer pre-sputter, oxygen and nitrogen available for reactive sputtering.	C	134	67
	Speciality Coatings PDC-2012 Parylene Deposition	Parylene N or C only, thickness to tens of microns.	C	88	44
Speciality Tools	Suss Microtec SB6e Wafer Bonder	Thermal, pressure and anodic bonding with vacuum or over-pressure condition.	E	160	80
	Tousimis Critical Point Dryer	Drying of high aspect ratio fragile structures on pieces to 150 mm wafers.	C	104	52
	Bruker-TMT Chemical Mechanical Planarization	Chemical Mechanical Polisher (100 mm wafer maximum).	E	102	51
Wet Chemistry	Microprocess Avenger Solvent Liftoff	Heated spray solvent liftoff, dry in dry out processing, substrates up to 150 mm.	C	150	75
Access	Cleanroom Occupancy Rate	Clean room entrance fee includes gowning, most wet chemistry, and metrology including: Toho Tech FLX-2320 Laser Film Stress Measurement Firsttenangstroms FTA32 Contact Angle Goniometer Woollam XLS-100 Spectroscopic Ellipsometer Nanometrics Nanospec reflectometer Bruker Dektak XT surface profilometer Jandel RM2 four point probe Microscopic and Macroscopic Optical imaging and inspection Hitachi TM-1000 small sample SEM up to 10 kx Keithley 4200 Parametric with capacitance, pulse, and high current modes.	-	72	36
	Processing Services	NanoFab Engineers can perform process development and run complex processes on your behalf in the NanoFab including mask layout with or without you present.	-	123	123
	Processing Services	NanoFab Process Technicians can run standard process on your behalf with or without you present.	-	72	72

Note: Location 'C' indicates that the tool is located inside of the cleanroom and incurs the clean room occupancy fee in addtion to the tool rate.
Location 'E' indicates that the tool is located outside of the cleanroom.

* All CMOS tools require a one time 2 hour NanoFab CMOS protocol training prior to CMOS tool training.

6/27/2014

CNST Center for Nanoscale Science & Technology

NANOFAB TOOL TRAINING RATES
Effective 6/30/14

Category	Tool	Typical Training Time	Individual Training Rate	Group Training Rate
		Hours	$/Hour	$/Hour
Chemical Vapor Deposition	Oxford FlexALRPT Atomic Layer Deposition	2	181	90
	Plasma-Therm Versaline High Density PECVD	1	195	97
CMOS	Unaxis Shuttleline ICP Etcher	2	212	106
	Tystar Wet Oxidation Furnace	1	199	99
	Tystar Dry Oxidation Furnace	1	199	99
	Tystar Sinter Furnace	1	166	83
	Tystar Doping Furnace	1	166	83
	Tystar Polysilicon Low Pressure CVD	1.5	192	96
	Tystar Silicon Nitride Low Pressure CVD	1.5	191	95
	Tystar Low Temperature Oxide CVD	1.5	194	97
Dry Etching	Unaxis Shuttleline Deep Si Etcher	2	189	94
	SPTS Omega c2L Deep Silicon Etcher	2	198	99
	Oxford PlasmaLab 100	2	191	95
	Oxford PlasmaLab 100	2	191	95
	Unaxis 790 RIE	2	180	90
	Unaxis 790 RIE	2	180	90
	XeF2 Silicon Etcher	1	188	94
	SPTS µEtch HF Vapor Etcher	1	173	86
	Microwave Asher	0.5	163	81
	4Wave Ion Mill	2	190	95
Gen Furnaces	Tystar Dry Ox Furnace	1	162	81
	Tystar Wet Ox Furnace	1	164	82
	Tystar Sinter Furnace	1	165	82
	Tystar Anneal Furnace	1	162	81
	Modular Process Rapid Thermal Annealer	1	203	101
Imaging and Analysis	FEI Titan Analytical TEM	40	208	104
	Zeiss Ultra 60 Field Emission SEM	4	189	94
	Fischione 1040 NanoMill Low Energy Ion Mill	2	200	100
	Wyatt Dawn Heleos II DLS	6	148	74
	Rigaku SmartLab 9kW X-Ray Diffraction	4	198	99
	Bruker Fast Scan AFM	2	191	95
	Asylum Cypher High Resolution AFM	2	188	94
	Veeco Dimension 3100 Atomic Force Microscope	2	188	94
Focused Ion Beams	FEI Helios 650 Dual Beam FIB/SEM	5	273	137
	Zeiss NVision40 Dual Beam FIB/SEM	5	252	126
Lithography	JEOL E-beam JBX 6300-FS	6	410	205
	Raith Elphy E-beam	4	189	94
	ASML Stepper PAS 5500/275	6	230	115
	Suss MA6 Contact Lithography	4	154	77
	Suss MA8 Contact Lithography	4	154	77
	Heidelberg DWL-66FS Laser Writer	4	190	95
	Nanonex NX-2000 Nano-imprinter	3	199	99
	Nanonex Ultra-100 Molecular vapor coater	2	189	92
Packaging	Disco 341 Dicing Saw	3	173	86
	K&S 4526 Wire Bonder	1	187	93
	Tresky T-3000-FC3-HF Flip Chip Bonder	2	197	98
Physical Vapor Deposition	Denton Infinity 22	2	187	93
	Denton Discovery 550	2	190	95
	Speciality Coatings PDC-2012 Parylene Deposition	1	197	83
Speciality Tools	Suss Microtec SB6e Wafer Bonder	4	203	101
	Tousimis Critical Point Dryer	1	175	87
	Bruker-TMT Chemical Mechanical Planarization	3	174	87
Wet Chemistry	Microprocess Avenger Solvent Liftoff	1	198	99
All Other Tools		Varies	123	62

Typical training times cover general tool operation and can vary depending on previous experience and aptitude. Application specific training beyond general tool usage will require additional training time and should be discussed with process engineer prior to training.

* All CMOS tools require a one time 2 hour NanoFab CMOS protocol training prior to CMOS tool training.